HYDROMETRICAL OBSERVATIONS AND EXPERIMENTS IN THE BREWERY.

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TO THE

SOCIETY FOR THE ENCOURAGEMENT

OF

ARTS, MANUFACTURES, AND COMMERCE,

LONDON.

My Lords and Gentlemen,

HUMBLY conceiving, that the purport of the following ſheets will be found to coincide with the views of your moſt reſpectable, and laudable inſtitution; I beg leave, with all due deference, to inſcribe them to the ſociety.

Notwithſtanding the principal part of this work conſiſts of examples, taken from actual practice in the brewery, it is preſumed that the utility of hydroſtatics,

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in contributing to the improvement of the arts and trades dependent on liquid extracts, is not confined to that branch; but that ſome hints may be hence derived, which may prove worthy the attention, alſo, of the malt diſtiller, and vinegar maker.

Each of theſe reſpective employs being engaged in different proceſſes on corn, hereby a relation is produced between the preſent ſubject, and the important concern of agriculture. For, by hydroſtatics may be aſcertained, to the utmoſt degree of preciſion, and certainty, the value of every kind of grain; and hence the exact ſuperiority or inferiority between any corn of like ſpecies, the produce of different climates. Thus we may be taught, how far the barley of Siberia exceeds in value the ſame kind of corn, produced in England;

or, in what degree the barley of one county in England is preferable to the ſame produce, in any other county. Other examinations will, probably, tend to afford the like information, reſpecting the intrinſic worth of different kinds of wheat. And the enquiries, in all the above caſes, may be extended to the moſt uſeful inſtruction, by aſcertaining the exact effects of different modes of huſbandry, on both the grains here mentioned.

The buſineſs of ſweets is, no leſs than the occupations dependent on corn, likely to be very materially benefited by the application of an hydrometer; as is attempted to be ſhewn in the following publication, in a ſection appropriated to that particular intent.

Submitting the whole to the perusal and attention of the society, I am, with the greatest respect

My Lords and Gentlemen,

Your most obedient, and

Very humble Servant,

Alton, Hants,
May 9th, 1785.

J. BAVERSTOCK.

PREFACE.

THE author of the following treatiſe having *now* uſed an hydrometer, during upwards of ſixteen years, ſo conſtantly as on no one occaſion in all that time to vend a ſingle caſk of beer, without having previouſly aſcertained the ſpecific gravity of the worts, and brought them to a ſtandard proportioned to the price of the beer, or to ſome ſtandard determined on by conſiderations, varying with the yearly produce and price of the materials; it is preſumed that it will not prove unacceptable to thoſe who may be intereſted or engaged in the brewery, that the reſult of his obſervations ſhould at length be made known.

He has the greateſt reaſon to believe, that he can render the information, afforded by this inſtrument, exceedingly uſeful to thoſe who are employed in that buſineſs. It may not therefore be improper to aſſign the cauſes why it was not publiſhed ſooner.

So long ago as in January, 1770, he put in the hands of the late Mr. B. Martin, a manuſcript, containing ſome obſervations and particulars of experiments, derived from the uſe of an hydrometer, which, about fifteen months before that time, had been purchaſed at his ſhop; which circumſtance, indeed, led the author to conſult him the firſt. When, notwithſtanding what he had himſelf aſſerted in his treatiſe, given with the inſtrument to the purchaſers thereof, namely, "that "it was uſeful in the diſcovery of the "ſtrength of beer, ale, wine, and worts," he was not, by any endeavours, to be prevailed on to aknowledge that ſuch an inſtrument could, by any device, or contrivance,

trivance, be rendered of ſervice to the brewery.

The fact was, that Mr. Martin had contrived this inſtrument for the ſervice of the diſtillery only; and, ſo far as he had any conception of its application to the brewery, had tried his hydrometer in various kinds of *beer*, and *ale*, inſtead of (as he ſhould have done) in *worts* juſt boiled, and previous to fermentation. And the ſpecific gravities of ſuch beers and ales depending, in ſome meaſure, on the degree of their fermentation, and on their caſual ſtate of ripeneſs and clearneſs, at the times when theſe experiments happened to be made, and not altogether on any other circumſtances, he found himſelf ſo bewildered, that he gave the matter up.

His ſurpriſe however appeared to be very great, when he was firſt told the actual and very material differences in the gravities of a firſt, a ſecond, and a third wort; a matter on which he ſeemed to have never once made any trials, notwithſtanding he was the conſtructor of an in-

ſtrument ſufficiently capable of deciding thereon.

Unſucceſsful with this gentleman, the author introduced himſelf to a late very eminent brewer; who entered very warmly into the ſubject, and was ſo kind as to ſign a declaration in the manuſcript before mentioned, expreſſive of his opinion of the utility of the inſtrument to the brewery.

It would be tedious and unintereſting to relate all the means, which were uſed to prevail on this gentleman alſo to neglect the uſe of the inſtrument; ſuffice it to ſay, that they were of ſuch a kind, that the author ſcorned to give himſelf the trouble to endeavour to counteract them. Some of the hydrometers intended for him proved very defective. And thus the author was induced to decline all thoughts of making the matter public at that time; contenting himſelf with applying the inſtrument daily in his own practice, and finding, from every ſucceeding year's experience,

perience, ſtill additional proofs of its extreme uſefulneſs, as well in reſpect to profit by the juſt directions it has afforded in the purchaſing of malt and barley, as alſo by its acting as the index to the proceſs of brewing, in ſhewing the different effects of varying heats and operations.

It will undoubtedly be ſuſpected and ſaid, that the cauſe why the gentleman above alluded to, or the people he employed, rejected the inſtrument in queſtion, might be the total incompetency of Martin's hydrometer in *principle*, rather than merely to the inaccuracy or defectiveneſs of the workmanſhip.

It is readily granted that much better inſtruments have been made ſince that time, by Quin and others. But this ſuperiority conſiſts *only* in the workmanſhip, and in the ſtrength of the inſtruments. The * form of each kind of

* It is to be noted, that we are here ſpeaking of *hydrometers*. The hydroſtatical balance differs from ſuch in form; although not, in reſpect to fluids, in application.

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them is the ſame; nor is there any diſtinction among them, provided they are equally well finiſhed, ſave in the ſcale or ſum of their indications; of which we ſhall ſpeak in another place. Martin's hydrometer ever was, it may be aſſerted from long experience, as *capable* of perfection as any other. And it appears to be ſelf-evident, that *any* inſtrument which ſerves to ſhew the comparative ſpecific gravity which one wort bears to another, with the preciſe, or very nearly the preciſe ſuperiority of each ſuch wort to water in different ſituations, (whether ſuch an inſtrument may or may not be ſufficiently nice to ſatisfy the enquiries of philoſophy) may be and is, ſo great are the differences between the worts, fully competent to the practical purpoſes and purſuits of the brewery. In which a ſmall variation, as far as 5, or even more in a thouſand, can never be an object worth notice.

It has been already obſerved, that the hydrometer acts as the index to the proceſs of

of brewing, by ſhewing the different effects of varying heats and operations. It is not hereby meant that the hydrometer will inform the brewer whether his proceſs is juſt, to the obtaining tranſparency, proper flavour, and the preſervative principles; which, abſtracted from more immediate views of profit, are the properties moſtly to be wiſhed for in beer. But only that the hydrometer indicates to the brewer the preciſe quantity of valuable matter, obtained from any given quantity of malt.

If, therefore, the brewer could by any contrivance, ſuch as the taking unuſual care and pains in the mixing a certain parcel of malt to the amount of his conſumption during ſeveral diſtinct brewings, make the whole exactly ſimilar in quality; whatever difference then appeared, in the total amount of the ſpecific gravity of the worts of each ſuch brewing, muſt be imputed to a difference in the heats of the water applied in the reſpective maſhes, or to ſome other variations in the proceſs.

And

And, thus, by the hydrometer is diſcovered a rule for eſtabliſhing the beſt proceſs, to the obtaining the greateſt poſſible quantity of valuable matter, from any certain number of quarters of malt.

The other properties of early tranſparency, ſimilarity of flavour, and due preſervation are to be obtained by proper regulations of the heats of the water uſed in the reſpective maſhes, and of the heat of the worts under the action of fermentation. All which heats reſt on the brewer's judgment; being obtainable to the utmoſt degree of exactneſs and preciſion, by the uſe of another and better known inſtrument, the thermometer.

But to return to the hydrometer. If the conſtant uſe of this inſtrument was to become univerſal in the brewery, the event would be the diſtinguiſhing which farmer produces the beſt barley, and which maltſter ſells the beſt malt. The real value of which, or the preciſe difference between different lots or parcels of them, may, by an hydroſtatical apparatus,

be diſcovered to ſuch exactneſs, as to a five hundredth part of the whole, if ſuch exactneſs ſhould be required. The author has frequently found ſuch differences as from five to ten, and fifteen per cent. in the goodneſs of malt made from barley even of the ſame ſeaſon; and a ſtill greater diſproportion, ſo much as 20 and 25 per cent. in malts made from barleys the produce of different years. Which is ſurely ſuch important information, afforded by this inſtrument, as of itſelf to prove the extreme utility derivable from the continued application of it. And if this information was to become general, it can be injurious only to ſuch farmers as may be negligent, and to ſuch maltſters as may be ſo unjuſt as to injure the quality of their malt, in their endeavours to obtain an unreaſonable increaſe of quantity.

The author has only to obſerve farther, on the following ſheets, that they are intended chiefly for the uſe and aſſiſtance of ſuch perſons in the brewery, as may not yet have ſeen, or perhaps ever heard

that

that there is ſuch an inſtrument as the hydrometer. This view or intention will account for his being more particular, on ſome occaſions, than may by others be thought neceſſary or proper. But the majority of readers will, he truſts, make allowances for that particularity, which can have no other object than their information and ſervice.

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ERRATUM.

Page 8, line 7, from the bottom, *for* ſuggeſt *read* ſuggeſts.

HYDROMETRICAL OBSERVATIONS AND EXPERIMENTS IN THE BREWERY.

SECTION I.

On the HYDROMETER *and the* HYDROSTATICAL BALANCE.

THE hydrometer is an inſtrument adapted to aſcertain the ſpecific gravity of all fluids, from the moſt denſe ſolutions down to common water, and from water to alcohol, or the higheſt rectified ſpirit. And as the weight of ſome fluids, and the lightneſs of others, are, generally ſpeaking,

the moſt deciſive proofs of their reſpective values, it follows that a judicious uſe and application of this inſtrument muſt be of very great ſervice to all thoſe who are intereſted in forming and vending liquid extracts, of whatever denominations.

In many parts of the proceſs of brewing, the hydrometer will be found to be ſuch a guide, as to merit the moſt earneſt attention. And, indeed, although the operator ſhould proceed in the moſt rational method, hitherto known or practiſed, and regulate his heats by the direction of a thermometer; yet he cannot have the ſatisfaction of knowing what quantity of valuable or fermentable matter he has obtained, but by means of this other moſt uſeful inſtrument.

But the hydrometer is not intended to anſwer the purpoſes of gratifying curioſity *only*. A few examples of real experiments will ſerve to evince that the inſtrument is applicable to ſome other, and more important ends in the brewery, as

well in regard to actual profit, as to the credit and reputation of the art, by the aſſiſtance which it affords towards reducing the practice to rules, formed on ſure and ſcientific principles.

Before we proceed to give theſe examples, it may not be improper to take ſome notice of another inſtrument, ſerving to determine the weight, or ſpecific gravity of fluids, called the Hydroſtatical Balance; which, it muſt be acknowledged, is, in its application, as effectual for the purpoſe it was intended to ſerve, as any other contrivance of the kind is or can be; notwithſtanding hydrometers are of later invention.

But the apparatus of the hydroſtatical balance is ſo complicated and troubleſome, and ſo much time is required to make an obſervation with it, that theſe conſiderations are ſufficient to determine the preference in favour of the hydrometer; which is remarkably convenient and expeditious, and as well adapted to aſcertain the gravities of different fluids, although

not at all ſuited to find thoſe of coins, and other ſolids, as is the balance.

Theſe remarks being premiſed, we now proceed to ſhew, experimentally, the uſe and application of the inſtrument.

SECTION II.

Application of the HYDROMETER *in examining different* WATERS.

IN making obſervations on the gravity of liquors, due regard muſt be had to the heat of the ſubject.

If the liquor be either hot, or very cold, a difference will be found, accordingly, in the weight of the very ſame fluid. For this reaſon it is requiſite that we ſhould have a ſtandard of heat for all our experiments. The moſt proper for the purpoſe appears to be a temperate warmth, or the point 55 degrees on Fahrenheit's thermometer. If the liquor exceeds this degree in heat, the gravity of it will be leſſened; and, on the contrary, if the liquor be colder than 55 degrees,

its weight will be proportionably increaſed.

We will begin with water; a ſubject of no ſmall importance to the brewer; whom it behoves to be well acquainted with that which he uſes, and to chuſe ſuch as is ſoft and thin; properties which are indicated by its lightneſs.

Accordingly we took the jar *, intended for the uſe of the hydrometer, and filled it nearly to the top, with clean rain-water. Putting the bulb of a thermometer into the water, we found the temperature of it to be 48 degrees. As

* This jar is an appendage to the inſtrument, and delivered with it from the maker. It is uſually of glaſs, or tin. But the brewer, who uſes an hydrometer conſtantly, will find it neceſſary to have three of them, and they will be more convenient, as being more ſtout, if made of copper. Tin is much more liable to be bruiſed, and cannot perhaps be kept ſo ſecurely ſoldered as copper, which is a conſideration of great conſequence, ſeeing that there is almoſt daily occaſion to immerſe theſe jars in water, for the more expeditiouſly bringing the worts to an examinable temperature. And, unleſs the jars are perfectly cloſe, the water might in ſome degree, communicate with the wort, to the deſtruction of the accuracy of the obſervation.

this was not warm enough for a juſt experiment, we dipped the jar, about three fourths of its length, into ſome water, which was hotter, for a minute, or until we found by the thermometer, that the heat of the ſubject was 55 degrees. Having obtained this point, we proceeded to put the inſtrument, with the water-weight ſcrewed on at the bottom, into the water, our ſubject. The value of this weight is to be eſtimated as 1000.

But the water would not quite ſupport the inſtrument, while this weight was on; and the hydrometer ſunk to the bottom. We therefore took the water-weight off; and in its ſtead ſcrewed on the weight uſed for the examination of ſpirits; which weight, compared with the water weight of 1000, may be eſtimated as 600; and placing in the cup, at the top of the inſtrument, ſeveral other weights to the amount, altogether, of 390 more, the ſtem of the hydrometer now ſunk to 8 of the diviſions, which are ten in number, marked on it. Not

content

content with its ſtanding thus; as not being yet, perhaps, perfectly aſſured of the truth of the actual ſpecific gravity of this water; by means of a ſlight touch with a finger, on the top of the ſtem, we ſend the inſtrument 4 or 5 diviſions lower, but on its reaſcending, after the removal of this preſſure, it, in a few moments, ſettled at its firſt number of diviſions 8. The ſum of all theſe weights therefore is as follows:

Proof ſpirit weight - - -	600
Weights in the cup - -	390
Diviſions on the ſtem - -	8
Weight of rain-water as -	998

In order to find how far rain-water is, in levity, preferable to that which is uſed in our brewhouſe, we filled the jar with ſome of this laſt, and, concluding that this would be found to be ſomewhat heavier, we took off the ſpirit-weight, and put on the water-weight 1000. Then bringing this to the due tempera-

ture, or 55 degrees of heat, we placed the hydrometer in it, and found the ſtem to ſtand at two of the diviſions, and that the weight of the water from our pump is

Water weight - - -	1000
Diviſions on the ſtem - -	2
Weight of the brewhouſe-water	1002

By theſe two obſervations it appears that the water uſed in our brewhouſe is denſer than rain-water by ,004, or 4 parts in a thouſand; and accordingly we are hereby taught that rain-water, if it was obtainable in a ſufficient quantity for our uſe, would be, in this proportion, more beneficial.

The reſult of theſe two experiments ſuggeſt to us, likewiſe, a concluſion, as highly probable, that the maker of the inſtrument, uſed on the preſent occaſion, purpoſely adjuſted it to ſink to its due point, (viz. ⊖ within the top of the ſtem) in Thames or in New River water, rather than in rain-water. In which intention

tention there could be no impropriety; ſeeing what immenſe uſe is daily made of thoſe two waters, in various chemical and commercial operations; and viewing, alſo, the impracticability of procuring, with certainty, a ſufficient quantity of rain-water for any ſuch purpoſes; whatever deſire there might be to uſe the one, in preference to the other. If therefore, this concluſion ſhould be admitted, our obſervation will ſtand thus, viz.

Rain-water - - -	998
Thames, or New River	1000
Water from brewhouſe well	1002

SECTION III.

Uſe of the HYDROMETER *in diſcovering the Value of* HOPS.

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of the hops employed; and thereby to diſtinguiſh, with all imaginable preciſion, the ſmalleſt differences between hops of different ſamples or plantations; as well as between the growth of even the ſame plantations, in different years or ſeaſons.

For this purpoſe, it has been recommended to boil a certain weight of hops, in a given quantity of water; on the ſuppoſition that the application of a thermometer to this infuſion, while it is boiling, will enable us to judge of the quality of the hops, by the increaſed number of degrees to which the thermometer then riſes, from the known heat of boiling water, or 212 degrees. But this is, in our opinion, a rule by no means ſufficiently accurate. The hydrometer may be certainly brought to anſwer the purpoſe, much more effectually.

The firſt attempts which we made on this ſubject, were directed to the firſt extract or wort; of which we endeavoured to find the value, or ſpecific gravity, previous to its going into the copper,

copper, to be boiled with the allowed quantity of hops. Could we have ſucceeded in this endeavour, the addition, occaſioned by any given quantity of hops, would be ſhewed by the additional denſity of boiled wort, compared with the ſame wort while raw, and unmixed with the hops; a due allowance being made for the evaporation, during the action of boiling.

But the difference between the firſt and laſt parts of the ſame wort, while running from the maſh-tun to the under-back, we found to be ſuch, as to render it impracticable to obtain a juſt or equal ſample of the whole; which is not to be done, until ſuch wort is rendered uniform, by ſome more ſtrong motion or agitation, than that which can be occaſioned by its merely running down from the maſh-tun to the under-back. Nor do we think, from the frequent trials we have made, that any dependence is to be placed on the application of the inſtrument to the wort from the taps,

or

or in the under-back, even when the whole is down.

We therefore determined to take another method, and to try what would be the effect on our inſtrument, occaſioned by boiling a given weight of hops, in a given meaſure, or quantity of water. Accordingly we procured a copper pot, which was well tinned within, and provided with a cloſe cover, capable of containing three pints of water; into which veſſel we put an exact quart of water from our pump, which we placed on the fire until it became boiling. The very moment that it began to boil, we took it off, and put into the water (ſtill in our three-pint meaſure) two ounces of the hops, the value of which we wiſhed to aſcertain. When theſe two ounces of hops were ſo fully ſaturated, as to be quite covered by the water, we again put the whole on the fire, until it boiled. Then fixing the cover on, very cloſely, ſo that none of the liquor could eſcape,

we

we let it continue to boil exactly ten minutes by a watch. As ſoon as the boiling was thus finiſhed, we ſtrained the whole, through a fine hair ſieve, into a clean tin pan. Then taking a ſufficient quantity to fill the jar ſo high as to admit the whole length of the hydrometer, we proceeded to take the ſpecific gravity of this extract.

So ſoon as this, after ſtanding a moderate time in the jar, appeared ſomewhat cool to the finger, we applied the thermometer, and found that our ſubject was at 64 degrees of heat. We therefore placed the jar, about three fourths of its length, in a veſſel of cold water, from the pump; until the contents were ſunk in heat to 55 degrees; and now putting the inſtrument, with the water-weight ſcrewed on, into the decoction, and adding the two ſmall weights marked 40, and 10, in the cup, we found the ſtem of the hydrometer to fix at the fifth diviſion.

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The value of the hops then is thus diſcovered:

Water-weight - - -	1000
Weight in the cup - -	40
Do. Do. - -	10
Diviſions on the ſtem - -	5
	1055
Deduct weight of water - -	1002
Value of the hops, or increaſed denſity in the water occaſioned by the hops	53

In order to prove the accuracy of the experiment we repeated it. But in this the niceſt ſkill and care are abſolutely neceſſary. If we deviate, though in the ſmalleſt degree, in any one part of the proceſs, a difference will be found.

An enumeration of thoſe particulars which require great caution, will appear to be a repeated deſcription of the whole proceſs. But ſtill, ſince the hydrometer cannot ſhew the comparative value of one ſample of hops to another, with that degree of juſtneſs and preciſion which

which is neceſſary, unleſs great diligence and exactneſs are obſerved; whatever tends to direct us in the performance of the experiment, cannot be unſerviceable.

1ſt. Then, we muſt take care that the copper pot into which the water is put, be very clean; and that not the leaſt remains of any other fluid, or matter, be joined to that water which is intended for the experiment.

2d. We muſt be particularly exact, in the quantity of water, and of hops; taking great care that the weight of the one, and the meaſure of the other, be preciſely the ſame, for one and every ſubſequent experiment; and, to this end, the meaſure, weight, and ſcales, ſhould be preſerved for, and uſed in, this ſingle purpoſe.

3d. We muſt diligently obſerve the water; ſo as to remove it from the fire, at the firſt moment that it boils, previous to adding the hops. For, the action of boiling, by expelling the air out of the water,

water, renders this laſt ſo much heavier in proportion to the time it is ſuffered to boil; and a difference muſt be found in the denſity of the decoction, proportionable to the increaſed denſity of the water, before the hops are added to it.

4th. Much the ſame reaſon may be aſſigned, for a diligent obſervation of the time, when the *infuſion* firſt boils.

5th. Not leſs is the neceſſity of confining all the water, during the time allowed for the boiling, by putting the cover on very tight, ſo that none can fly out at the top; for as we find that ſimple water is conſiderably lighter than our infuſion, it follows, that the ſpecific gravity of this laſt will be in proportion to the greater or leſs quantity of water; ſuppoſing the quality and quantity of the hops to be the ſame.

It may not be unneceſſary to obſerve here, that the quantity of any fluid, to ſerve for a ſubject for the hydrometer, makes not the leaſt difference, as to the gravity of it, when it is in the jar; provided

vided there is ſufficient to ſuſpend the ball, and cover the ſtem of the inſtrument. The hydrometer being formed on ſuch principles, that it is not the *quantity* of the liquor *in the jar*, which adds to, or diminiſhes the apparent ſpecific gravity thereof—but the more or leſs denſe quality of the ſubject; which ſuffers the hydrometer to occupy ſuch a ſpace only, in the liquor, as is proportioned to the denſity of the fluid, when compared to the power given to the inſtrument, by the proper and due addition of weights in the cup, at the top of the hydrometer.

SECTION IV.

Uſe of the foregoing EXPERIMENT.

HAVING given theſe directions, for the performance of our experiment on hops, we ſhall now proceed to ſhew the uſe and application of it; and endeavour to convert it to ſuch purpoſes as,

it is conceived, muſt be of great ſervice, in directing and informing the brewer, what quantity of hops, of a certain (thus aſcertained) quality, will be ſufficient to anſwer any required purpoſe.

Suppoſe 112lb. of theſe hops, the value whereof is as 53, to be, on due proof, a ſufficient quantity to preſerve a brewing or guyle of beer, for a length of time ſuitable to the brewer's demand and intentions.

It is required to know, what quantity muſt be uſed, in order to anſwer the ſame purpoſe, of another growth or parcel of hops; the value whereof, ſubtracting the gravity of the water, is as 56?

Rule. Multiply the value of the firſt ſample 53, by the number of pounds 112, and divide the product by the value of the other growth, or ſample, 56.

Work

Work - - 53
112
106
583
56)5936(106 pounds
336

Thus we find that 106 pounds of the hops, of this laſt ſample, are equivalent in uſe to 112 pounds of the other.

Suppoſe, on the other hand, the value of another ſample ſhould be no more than 48, what quantity of that growth will be required to anſwer the ſame purpoſe?

Work - - $\left\{\begin{matrix}53\\112\end{matrix}\right\}$ as before.
pounds.
48)5936(123,66
113
176
320
320

Anſwer 123,66, or ſay 124 pounds

of this ſample equivalent to 112 pounds of the firſt, or to 106 pounds of the ſecond ſample.

It is preſumed that the uſe of theſe experiments, and the advantages which might be obtained from a frequency of them, if made with due preciſion, and exactly minuted, and noted, muſt be obvious to every one. Generally ſpeaking, an opportunity might be obtained to prove a ſample of hops, or to examine a choice of ſamples, by our inſtrument, previous to an abſolute purchaſe of them. In this caſe, it might happen, alſo, that an equal, or higher price might be demanded for the lot, the value of which we have found to be only 48, than for the lot of the value of 56.

But whatever prices may be fixed, the brewer has hereby an opportunity of aſcertaining the preciſe quantity of unctuous (which is the preſervative) matter, and of determining, accordingly on the price, to great advantage. It

is true there is another property in hops, of great conſideration, which is wholly out of the reach of any inſtrument, and that is flavour; which is ſtill, however, open to the uſual mode of diſcrimination, and therefore what we aſſert is, that if it ſhould be found that our ſample 56 is equivalent *in flavour* to the lot or ſample 48,—the former is, on the whole, preferable to the latter, in the ſame proportion, that five pounds and twelve ſhillings are preferable to four pounds and ſixteen ſhillings.

SECTION V.

Uſe of the HYDROMETER *in diſcovering the Value of* WORTS, *and in aſcertaining the mean Specific Gravity of two* WORTS.

TRUSTING therefore, that enough has been ſaid to prove the utility of the inſtrument, ſo far as it may be

applied to aſcertain the intrinſic value of the two preceding ſubjects, water and hops; we ſhall now proceed to illuſtrate the uſes of the hydrometer ſtill farther, by employing it to diſcover the ſpecific gravity, and thereby the ſtrength and true value, of the different extracts, or worts.

In the country brewery, the length or quantity of beer is, moſt uſually, formed by two worts for ſtrong, and a third, or the laſt, wort for ſmall. In the London, and in ſome large country breweries, this length, as it is termed, is moſt commonly made by uniting the three worts in one fermenting guyle. The rules, which we ſhall give for explaining the preſent deſign, will be founded on examples, taken from the practice in both theſe inſtances.

We conclude that the copper, coolers, and every other veſſel and utenſil employed during any part of the proceſs of brewing, are kept ſcrupulouſly clean. When the worts are duly and ſufficiently

ſufficiently boiled with the hops, they are, each in their turn, emptied from the copper, and running through a hair-cloth, or falſe bottom, they, thus ſtrained from the hops, paſs regularly into the backs, there to lay in order to cool, previous to fermentation. The two worts, intended for one guyle of ſtrong, muſt, in the backs, be kept diſtinct from each other; which is very eaſily done, provided the brewhouſe is conſtructed, and the coolers are fixed, purſuant to the modern convenient plan.

The worts having now been ſo long in the coolers, as to ſink to a fermentable heat, or nearly thereto, we take the jars, appertaining to the inſtrument, and dipping them in the coolers, in ſuch a gentle, and careful manner, as not to move any part of the ſediment, from the bottom of either cooler, we take out a ſufficiency of each wort for the experiment. And, bringing each to our ſtandard temperature, or 55 degrees of heat by Fahrenheit's thermometer, we

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apply the hydrometer, (with the water-weight fixed on at the bottom) and, placing ſuch a number of additional, weights at the top of our inſtrument, as each wort will bear reſpectively; we thereby diſcover the preciſe denſity of each. For inſtance, to prove the firſt and ſtrongeſt extract, or wort, we ſeverally place on the top of the inſtrument, the two weights marked 300, and 100, but, finding that the denſity of the wort ſtill keeps the ball of the hydrometer ſuſpended, conſiderably above the ſurface of the liquor, we take off the weight 100, and in its ſtead place the weight 200. As this is not yet ſufficient to ſink the inſtrument, we add the ſmall weight 40, and to this the weight 30. And the application of this laſt cauſes the hydrometer to ſink to the bottom. We therefore remove the weight 30, and place 20 in its ſtead. And now the inſtrument, after moving gently up and down, fixes; but without touching the bottom; and examining

ing the ſtem, we find that five of the diviſions remain uncovered by the wort.

The ſum of theſe weights therefore is as follows:

Water-weight	-	-	1000
Weight at the top of the ſtem			300
Do.	Do.	- -	200
Do.	Do.	- -	40
Do.	Do.	- -	20
Diviſions on the ſtem	-	-	5
			1565
Deduct for weight of water		-	1002
Specific gravity of the wort		-	563

Having thus found the weight of the firſt wort, we proceed by the ſame means, to diſcover the value of the ſecond.

We begin, accordingly, with placing on the ſtem the weight 300, and, finding that this power is nearly ſufficient to ſink the ball of the hydrometer, we add only the ſmalleſt weight 10, and then

perceive the ſtem to fix, and three diviſions to remain above the ſurface. The value of this wort therefore is

Water-weight - - -	1000
Weight on the ſtem - -	300
Do. - - -	10
Diviſions - - -	3
	1313
Deduct weight of water - -	1002
Specific gravity of ſecond wort -	311

The difference between theſe two worts appears to be 252, or as about 6 to 11, which is not a great way from two to one. The mean value of the two worts is readily diſcovered, provided the quantity of each is equal.

Firſt wort - -	563
Second wort - -	311
	874
The medium - -	437

But if the quantity of either wort is greater

greater or leſs than the other, ſtill the mean value of the two is to be found very exactly. We will ſuppoſe theſe two worts to lay in two backs or coolers, the dimenſions whereof are equal, but the depths of the worts different.

Taking the depth of the firſt wort to be 2,8 inches, and of the ſecond to be 2,3 inches, what is the mean ſpecific gravity?

Rule. Multiply the weight of the firſt wort 563 by its depth in the cooler, 2,8. And the weight of the ſecond wort 311, by its depth 2,3. Add the two products, and divide by both depths.

Work -	563	311
	2,8	2,3
	450,4	933
	1126	622
2,8	1576,4	715,3
2,3	715,3	
5,1)	2291,7 (449 the mean gravity of theſe two worts.	
	251	
	477	
	18	

The

The ſame rule will lead us to the diſcovery of the mean value, when the quantity of the ſecond exceeds that of the firſt.

As ſuppoſing the depths of each wort to be *vice verſa*.

	563	311
	2,3	2,8
	1689	2488
	1126	622
2,3	12949	8708
2,8	8708	
5,1)	21657 (424	
	125	
	237	
	33	

is in this caſe the medium occaſioned by the variation in the quantities, although the ſpecific gravity of each wort, diſtinctly, is the ſame as in the former example.

This ſhews the neceſſity of attending ſcrupulouſly to the quantity of each wort, in forming our average, or mean. Since we find the difference in the two caſes to be very nearly 6 *per centum*. The preceding rules, for diſcovering the mean denſity of two worts, are founded on the preſumption that the areas of each

cooler

cooler are equal. But if it ſhould happen otherwiſe, the medium may nevertheleſs be found, with equal preciſion, by a proper uſe of figures. We will ſuppoſe the area of the firſt cooler to be 192 gallons, and the ſecond to be 175 gallons, the depth in each cooler, and the ſpecific gravity of each wort, to be the ſame as in the firſt of the two preceding examples; what is the medium value of the whole guyle, or brewing?

Rule. Reduce the contents of each cooler into barrels; multiply the weight of each wort by its number of barrels; add the two products, and divide by the contents in barrels in the whole guyle.

	Gal.	
Work	192	175
	2,8	2,3
	153,6	525
	384	350
Gal.	36)537,6(14,93	36)402,5(11,18
	177	42
	336	65
	120	290
	12	2

The

The queſtion is now reduced to the following ſtate:

Wort	Bar.	Sp. Gra.
Firſt - -	14,93	563
Second -	11,18	311
Whole guyle	26,11	

Proceed thus,

	563	311
	14,93	11,18
	1689	2488
	5067	311
	7882	3421
Value of 1ſt wort	8405,59	3476,98
Value of 2d wort	3476,98	
Divide by - 26,11	)11882,57(455	the mean gravity of the whole guyle or brewing for ſtrong.
	14385	
	13307	
	252	

The ſame rule will of courſe ſerve, ſuppoſing the depths to be changed.

In this caſe, the mean gravity will be found to be not quite 419. It is hoped that the preceding rules will not appear ſo troubleſome and perplexing, as to occaſion

occaſion their being totally neglected; or to cauſe the inſtrument to be brought into diſrepute. Nothing is more eaſily, or more expeditiouſly diſpoſed of, than queſtions depending on figures; when an habit is once obtained of recurring to figures frequently. In the caſe before us, we have been fractionally exact; principally with a view to obviate any objections which might be urged againſt the accuracy of our inſtrument, or of our mode of applying it. But, in actual practice, this is not ſtrictly neceſſary. To exemplify this, let us, inſtead of 14,93 barrels of our firſt wort, take the quantity to be 15 barrels, (the difference being *not* three gallons in 540 gallons) and, inſtead of 11,18 barrels of ſecond wort, take the whole number 11 barrels, diſregarding the fractions amounting to 6,5, or 6 gallons and a half. In this ſituation, the queſtion becomes exceedingly ſimple, and anſwerable by very few figures.

Barrels

	563	311
	15	11
Barrels.		
15	8445	3421
11	3421	
26)	11866 (456 the mean gravity.	
	146	
	166	
	10	

Here we find a difference of 1 only in 456, which is ſurely not worthy the leaſt notice, in any perſon's practice.

SECTION VI.

Application of the HYDROMETER, *in diſcovering the mean Specific Gravity of three* WORTS, *and in forming Standard Gravities, with either two or more* WORTS.

THE preceding examples are founded on a ſuppoſition, that the two firſt worts are intended to form one guyle or

or quantity of ſtrong beer; and that a third wort is afterwards obtained from the ſame griſt, or maſhing of the malt, of a quality ſerving for ſmall-beer. This third wort, when put in eſtimation with the two former, will be found to be in quantity about equal to either one of them; and in quality, as 100, or 120, by our inſtrument.

In ſmall breweries it may happen, that the demand for table-beer may be in this proportion, viz. one of ſmall to two of ſtrong. In ſuch caſes, the former mode of brewing is ſuitable and advantageous; as providing a proper ſupply of both ſtrong and ſmall, conſtantly and regularly. But in larger breweries, generally ſpeaking, the caſe is very different. Where a very great quantity of ſtrong-beer is demanded, the providing of table-beer is left to thoſe, who may find it to be worth their while to make a diſtinct buſineſs or employ of brewing this ſort. Or, if in large breweries it is found neceſſary or convenient to pro-

duce any ſmall-beer, the proportion to the quantity of ſtrong is uſually very little.

Where, therefore, a brewery is eſtabliſhed on this plan, the quantity of malt maſhed at each time, is very large; the firſt extract or wort very denſe and rich, and the ſucceeding two worts, as well as the firſt, preferable in quality to the extracts produced from ſmaller maſhes. The water being proportionally more abundant in thoſe brewings, where it is intended to make ſtrong-beer of two worts, and ſmall of one, than in the brewings we now purpoſe to treat of; in which the three worts are intended to form one guyle, or quantity, of one quality, or ſtrength, for ſtrong beer.

Suppoſe that from the quantity of malt wetted, and of hops boiled with the extracts, the produce ſhould prove to be,

Barrels.

Barrels.	Wort.	Gravity.
42,5	firſt at	626
44,7	ſecond	364
42,8	third	155
130,0		

What is the mean value, or ſpecific gravity of the three worts?

Multiplying the gravity of each wort by its reſpective quantity, and dividing the aggregate ſum by the whole number of barrels 130, the quotient 380,8, or ſay 381, will ſhew the mean ſpecific gravity of this guyle.

After what has been ſaid on the method of finding the mean value of two worts, it is preſumed that this ſingle inſtance will be a ſufficient direction, to aſcertain the mean of three worts.

A more important conſideration ariſes from the premiſes; which is the *application* of the information pointed out to us thus by our inſtrument. We ſhall, accordingly, endeavour to ſhew ſome of the advantages reſulting to the brewer

from a due attention to the material information here afforded, by adapting it to anſwer ſome deſirable and advantageous ends, in the practical parts of his buſineſs.

The candid and fair trader cannot but enjoy a very pleaſing reflection, when he finds that he has ſecured to himſelf the favour, and good opinion of his cuſtomers.

For this purpoſe, it is incumbent on the brewer to uſe ſuch means, as a rational theory, confirmed by his own practice, teaches him are moſt likely to conduce to the improvement and perfection of his beer. But, as it is neceſſary, as well for the credit of the brewer, as of his product, that this laſt ſhould, among other deſirable properties, be of a ſufficient ſtrength to extend the ſale of it; ſo muſt it be uſeleſs, with reſpect to the conſumer, as well as a conſiderable loſs to the brewer, in a deduction of his profits, that he ſhould ſend out his beer of a quality ſuperior to what

is

is expected, or desired by his customers. The position which we here mean to lay down, and which we presume cannot be controverted, is, that *supposing the extent and the degree of the fermentation to be the same, the strength of the beer, in a drinkable state, will be in an exact proportion to the specific gravity of the worts, from whence such beer is formed.*

Now, it is practicable to regulate the fermentation to the greatest degree of uniformity, and precision, by the use of a thermometer, as readily as the specific gravities of the worts may be ascertained by the hydrometer. Hereby then, and by the use of these two instruments only, are afforded the means of producing malt-liquors, constantly similar in taste and in effects.

It is absolutely impossible here to fix on such a point of density as may be said to be a true value, or standard, for any sort of beer. All that can be said, on this head, is, that a few observations

on different guyles will teach the brewer, how to adapt the denſity of his worts to his own price and profits, as well as to the taſte and expectations of the conſumers.

Theſe being different, as the different local trades in this branch throughout the kingdom, we ſhall exemplify the means of attaining average ſtandard gravities in two extremes, namely, the London porter brewery, in which the length is very large, and the country pale-beer brewery, in which the quantity drawn from a given number of quarters of malt is proportionably much leſs.

It is to be obſerved, that we do not venture to give theſe examples as the actual ſtandard in either caſe. All that we intend, or propoſe, is to give ſuch explanations as may ſerve to direct the practitioner to make up his own ſtandard, in any inſtance which may occur; which ſtandard, as has been obſerved before, varies with ſituation and price. Was the author to give here his own real ſpeci-

fic

ſic gravities, it could be of no ſervice to any one in another part of the kingdom.

We will ſuppoſe then, that after a proper variety of trials made, in regard to the palates of the conſumers, a degree equal to 450 ſhould prove to be a ſaleable denſity for ſtrong-beer, or ſtrong-ale at 40s. per barrel, and that 360 ſhould be a ſatisfactory gravity for inferior beer; which, as it is charged with the ſame exciſe, or duty, may perhaps be ſold from 30s. to 34s. per barrel. We will, accordingly, call theſe points, or 450 in one inſtance, and 360 in the other, our ſtandards of denſity. And now, in all our future brewings, we muſt add to the value of our worts ſo often as they happen to be leſs than our ſtandard, and reduce them when their mean ſpecific gravity exceeds the ſtandard.

As the reduction muſt be performed by a greater quantity of ſmaller wort, or beer, ſo the addition of gravity muſt be effected

by a greater proportion of ſuch wort, or beer, as is conſiderably ſtronger than the mean of that which is deficient.

We ſhall give an example in each caſe; and ſhew that the quantity which may be required, either for addition, or reduction, is diſcoverable with great eaſe, and to great preciſion, by the uſe of figures.

And firſt, in the inſtance of two worts intended to form one guyle of ſtrong. Suppoſe we find the coolers to contain of worts when ſunk to a fermentable degree of heat, or very nearly thereto, 23 barrels of the gravity 558, and 23,5 barrels of the gravity 305. What method is to be taken to improve this guyle, (the mean gravity whereof will be found to be no more than 430) ſo much as to bring it to our ſtandard 450?

Either an additional quantity of firſt wort ſhould be introduced during, or ſubſequent to the fermentation, or elſe a certain portion of the ſecond wort ſhould be kept back; juſt as may be moſt

convenient

convenient to the brewer's peculiar proceſs, or to the conſtruction of his office, and number of utenſils. To know how much of the ſecond wort ſhould be reſerved, the following rule will direct.

1ſt. Find the difference between the intended ſtandard, 450, and the gravity of the ſecond wort, 305.

2d. Find the difference between the mean of the preſent brewing, 430, and the ſecond wort, 305.

Multiply the length 46,5 barrels by the ſmalleſt difference, and divide that ſum by the largeſt; the quotient ſhews what muſt be the quantity of the guyle; and the difference between this quantity and the length, 46,5 barrels, is the quantity of ſecond wort to be reſerved.

Work 450 required mean. Bar, 46,5
305 ſecond wort. 125
1ſt, dif. 145 Bar. 125 2d. difference.

145)58125(40,08

6,42 of the ſecond wort to be reſerved.
46,5

430 preſent mean.
305 ſecond wort.

The

The guyle will then conſiſt of 23 barrels, of 558 ſpecific gravity, and 17,08 barrels, of 305 ſpecific gravity.

To prove the rule and the work, ſee what will then be the mean:

558	305
23	17,08
12834	5209,40

Add - 12834

Divide by - 40,08)18043,40(450 the mean.

A queſtion now follows, viz. How this quantity of 6,42 barrels of wort, of 305 gravity, is to be diſpoſed of, or what uſe is to be made of it?

It may be fermented by itſelf, and reſerved as the means of reducing ſome future brewing, perhaps the operation of the very next day, which might be purpoſely performed with a leſs allowance of water, with a view to bearing ſuch a proportion of inferior wort.

If

If therefore the produce of the next enſuing, or any future proceſs, ſhould prove to be 22,3 barrels of the gravity 604, and the like quantity of a gravity 336; the mean of ſuch a guyle would be 470. Let us then ſee how much of our wort of the gravity 305, not before diſpoſed of, theſe 44,6 barrels of 470 will bear, ſo as to leave the guyle of a value not leſs than 450.

Rule. Find the difference between the ſtandard 450, and the reducing wort 305.

2dly. Find the difference between the mean of the preſent brewing 470, and the wort 305.

Then, multiply the length 44,6 barrels by the largeſt difference, and divide by the ſmalleſt; the quotient ſhews what muſt be the quantity of the whole guyle; and the difference between this quantity, and the length 44,6 barrels, muſt be ſupplied from the reducing wort.

450 required mean.
305 reducing wort.
145

Bar.
44,6
165
2230
7136

Bar.
145)7359o(50,75
44,6
6,15 of 305

470 preſent mean.
305 reducing wort, or beer
165

The guyle will then conſiſt of 44,6 barrels, of 470 ſpecific gravity, and of 6,15 of 305, which brings the mean to 450, as proved by the following work.

Bar.
44,6 of 470 20962
6,15 — 305 1875,75
50,75 divided in - 22837,75(450 the mean.

It is preſumed that theſe two examples will ſuffice, in directing the brewer to form the ſtandard ſpecific gravities, with two worts. The addition of the improving or reducing wort may, as has been before obſerved, be made either in the

the fermenting ton, or by a due diviſion of the whole quantity among the caſks, according to their contents, when in the cellars*. This muſt be left to the brewer's own judgment, as depending on, and varying with, the particular circumſtances of his trade, and conveniency of his utenſils.

Indeed, it may be aſſerted, once for all, that to make any uſe of the inſtrument on any one occaſion whatever, an habit of attention, no leſs than a perfect knowledge of the principles and practice of arithmetic, is abſolutely neceſſary.

But it may, at the ſame time, be ſaid that no part of this is difficult, or that at all events, the whole of it may be ſpeedily obtained, by due induſtry and application, accompanied with a moderate ſhare of ſkill and ingenuity.

We ſhall now proceed to point out

* Suppoſing ſuch wort to have been already fermented.

our method of forming ſtandard gravities, with three worts.

Suppoſe that from any given quantity of malt and hops, the produce in the coolers, taking out ſamples of each, and bringing them to the temperature 55 degrees of heat, ſhould be

	Bar.	Grav.
Wort 1.	39,5	622
2.	43,7	316
3.	45,8	118

The ſpecific gravity of each wort being multiplied by its own quantity, and the ſum of the whole being divided by the total number of barrels, 129, the mean denſity will be found to be 339.

Now, this being a quality not likely to prove perfectly ſatisfactory to thoſe conſumers who have been accuſtomed to malt-liquor, formed from worts of the denſity 360; ſo much of the third or loweſt wort (of 118) muſt be kept back, as will ſerve to leave the remainder

mainder of the guyle at the ſtandard 360. The quantity to be reſerved is ſhewn by the rule, before given.

	360	required gravity.		339	preſent mean.
	118	third wort.		118	third wort.
		Bar.			
1ſt. dif.	242	129		221	
		221			

242)28509(117,8 barrels at 360
11,2 ditto 118
129

The guyle will then conſiſt of the the following component parts, viz.

39,5	barrels at	622	24569	
43,7	ditto	316	13809	
34,6	ditto	118	4082,8	
117,8	which when divided in		- 42460,8	ſhews
With 11,2	barrels at 118 reſerved.			360

Theſe 11,2 barrels of third wort are of a very ſuitable quality for ſmall-beer. And, indeed, as almoſt every public brewery has ſome occaſion for ſmall-beer, a more convenient mode, to produce a ſupply, cannot perhaps be adopted than to make long lengths (as is the technical

nical term) with a view to reſerving juſt ſo much of the laſt wort, for ſmall-beer, as may be found to be requiſite to the bringing the two former worts to our ſtandard, whatever that may be *.

To reduce the aggregate value of three worts, when their mean exceeds the ſtandard determined on, either an additional quantity of inferior wort muſt be introduced, or a part of the ſtrongeſt extract reſerved. Taking, therefore, our example, page 35, as the ſubject of our operations, let it be required to ſay what quantity of wort ſuch as we laſt reſerved (of 118) muſt be added, or what quantity of the firſt extract of our preſent example (of 626) muſt be deducted, to reduce the mean of theſe three worts 381, to the ſtandard 360.

* If this method ſhould not be approved of, leſs quantities of water in the ſecond and third extracts of the future operations of the ſeaſon will, of courſe, bring the three worts nearer to the ſtandard.

360 381
118 118
242 Bar. 263
130

242)34190(141,28
130,

11,28 of 118 muſt be added.

The exact mean will be then found to be 360.

Or 626 626
360 381
266 Bar. 245
130 130
266 31850(119,74, or ſay 119 barrels ¾.

10,26 barrels muſt be deducted from the firſt wort; the guyle will then conſiſt of the following parts:

		Grav.
32,24	of firſt wort at	626
44,7	. ſecond	364
42,8	third	155
119,74	the mean whereof will be found to be 360.	

The inconvenience and trouble attending the diſpoſal of the reſerved wort may be urged, perhaps, as a ſtrong objection to the whole of our ſyſtem, by thoſe who may entertain ſuch an averſion to trouble of any kind, as to chuſe, on that account, to truſt to chance, rather than by rule and method to obtain preciſion and certainty. It is to be expected, that all our recommendations of the inſtrument, as well as all our directions as to the application of it, will be wholly thrown away on this deſcription of perſons. In large and extenſive breweries, where the operations are daily, this trouble will be proportionally greater than in ſmaller trades.

But here it might be exceedingly well worth the proprietors conſideration, to appropriate a fermenting ton, of a ſize ſuitable to the occaſion, for the purpoſe of receiving the ſurplus of worts, in either or any caſe. And, it might frequently happen, that thus the ſurplus of one day may ſerve to correct

ect the deficiency of a former, or ſucceeding guyle.

But this is one of thoſe circumſtances which (as has been ſaid before) muſt be left to the brewer's own determination, and contrivance. Another and more forcible objection may be made againſt that method of reduction, which governs our laſt example; namely, the reſerving a part of the firſt extract; inaſmuch as we thereby deprive the remainder of the guyle of a conſiderable portion of the moſt nutritious, moſt balſamic, and moſt highly flavoured properties, both of the malt and hops. This, as we have ſaid, is an objection truly forcible. And, therefore, the method ſhould not be practiſed, without great neceſſity, which will ſeldom be found to occur, to an ingenious operator. At leaſt, if it happens once in a ſeaſon, from the unexpected richneſs and good quality of the malt, the intelligent brewer will take care to provide accordingly in future, or ſo long as he is uſing the malt of that

ſeaſon, and ſo far as he can judge of that value, by employing a greater abundance of water in the ſecond and third extracts. For any thing farther, on this part of our ſubject, we ſhall refer the reader to the remarks we have made, on occaſion of reſerving 11,2 barrels of the third wort, in our example of improving the mean ſpecific gravity of a guyle, page 47. Adding only thereto, that this is, in our judgment, the method of all others hitherto recommended for applying the inſtrument, the moſt practicable, the moſt accurate, and the moſt beneficial.

SECTION VII.

Uſe of the HYDROMETER *in diſcovering the preciſe Value of different Maſhes, or Parcels of* MALT.

THE hydrometer by diſcovering the mean gravity of worts, points out to us a method of aſcertaining the whole value of the maſh, or parcel of malt, employed

ployed in producing ſuch worts; and, thereby, the exact value, to one penny or leſs, of each quarter compoſing ſuch maſh, or whole griſt. The method is, to reduce each quarter of malt to a certain produce of denſity, by dividing the whole ſum, or value of the maſh, by the number of quarters uſed.

Suppoſe, that from 20 quarters of malt we ſhould extract a guyle, containing 44,6 barrels of 425 ſpecific gravity; what is the value of each quarter of malt, indicated by the ſum of its denſity?

Rule. Multiply the gravity 425 by the number of barrels 44,6, and divide the product by the number of quarters of malt employed, 20.

425
44,6

2550
1700
1700

Divide by 20) 1895,50 amount of the aggregate value of the whole griſt.
947,75 denſity of each quarter.

Again. Suppoſe that from the ſame quantity of malt we ſhould obtain a guyle of 45,4 barrels of 466 ſpecific gravity; the denſity of each quarter will be then found to be as 1057,8. Now ſetting the price of the malt uſed in the latter example, at 36 ſhillings per quarter, what price ought to be given for a quarter of that malt, the ſum of the denſity of which is only as 947,7? ſay

If 1057,8 — 36 — 947,7

36

56862

28431

1057,8)34117,2(32,25 s.

Thus we find that 32,25, or 32 ſhillings and three pence, is the preciſe value per quarter of one lot, or parcel of malt, when put in eſtimation with the other ſample, which was to be purchaſed at 36 ſhillings the quarter. The ſame rule will ſerve in all inſtances. And we can, with confidence, aſſert that

ſuch

ſuch a difference, as we have here ſpecified, is to be diſcovered almoſt every ſeaſon, in malts apparently nearly equal in value, as judged of only by the uſual and common modes of examination; and when, conſequently, the difference in their prices is ſo trifling, as to bear no proportion to the difference in their intrinſic worth. Placing our two ſamples or parcels of malt in another point of view, and inverting the ſums of their denſities, we learn that 947,7 quarters, of one quality are equal in the production of wort, or valuable matter, to 1057,8 quarters of the other, or that nine quarters of the one are as valuable as ten quarters of the other.

But, ſuppoſing that the two maſhes, or parcels of malt, which were employed to produce the two preceding guyles of this different denſity, were, nevertheleſs, taken from one and the ſame heap, or large parcel of malt.

We will go farther, and conclude that this whole heap of malt was made from

a quantity of barley, the produce of one and the ſame farm; that the proceſs, obſerved in malting each different wetting and floor of this corn, was as nearly as poſſible the ſame; and furthermore, in order to render this whole parcel of malt perfectly equable, ſuppoſe that a proper number of perſons were employed to ſcreen and throw the whole to and fro, ſo often as to mix and unite the whole, moſt intimately and uniformly.

In ſuch a caſe, to what ſhall the brewer impute this material difference in the denſity of his worts, and the yield of his malt?

Is it not obvious, that the brewer muſt have varied in his operations, during ſome part or other of his proceſs when brewing?

Will he not, accordingly, refer to the book, where we conclude (if he acts prudently and rationally) each part of the proceſs, obſerved in every day's brewing, is exactly and conſtantly noted and minuted?

Will

Will he not there principally, and moſt attentively, examine what were the ſeveral degrees of heat, at which his different quantities of water were turned out of the copper, for the maſhes; what were the calculated heats of theſe maſhes, and what the actual heat of each tap, when running; and how far theſe calculated and actual heats differ?

Thus, though it muſt be by the uſe of a thermometer only, that we can *obtain* any required heat, for the different maſhes, (a part of the proceſs of brewing which is univerſally allowed to be of the utmoſt conſequence) yet is it manifeſt, that the hydrometer is the beſt *guide* to direct us in the diſcovery of this very capital and important deſideratum, the moſt profitable degrees of heat, for the maſhes; by ſhewing, as we ſee, the different effects of different degrees of heat.

And ſurely we may hence very reaſonably conclude, that by a due attention to the circumſtances of different brewings, (we mean of ſuch brewings as

are

are regulated by a thermometer) and by an obſervation of the different effects of varying operations, as aſcertained by the hydrometer, the brewer may, in due time, hope to arrive at ſuch preciſion in his art, as will make him ample amends for any application, or pains, which may be neceſſary.

SECTION VIII.

Of the different kinds of HYDROMETERS.

THE preceding rules are formed on the ſcale of Mr. Martin's hydrometer; but they are juſt as applicable, and that with the greateſt eaſe, to any other hydroſtatical inſtrument.

This leads us to ſpeak, more particularly than hitherto, of the various kinds of hydrometers now made. Some of them, by their makers, claiming the merit of being ſingle in utility, and condemning all the others as totally ineffi-cient.

Whereas, the fact is that they are all or any one of them, provided they are well finiſhed, and perfect of their kind, fully competent to their propoſed end. The principle of their operation not admitting of any conſiderable variation in their form; and the difference among them all conſiſting, principally, in the ſcale, or in the ſum of their indications.

In the conſtruction of this inſtrument, the firſt thing required to be done is to adjuſt it, ſo as that it may ſink to very nearly the top of its upper ſtem in rain-water, at a certain temperature of heat to be determined on by the maker. The whole length of this ſtem ſhould be equal in eſtimation to the ſmalleſt of all the deſigned weights, and graduated in a certain number of diviſions, amounting altogether to the difference in value between the loweſt and the next increaſed weight. Suppoſe the loweſt weight ſhould be eſtimated as 10. The difference, between the top and the bottom of the upper ſtem, ſhould be equal to this weight. The intermediate

termediate gradations on the ſtem will then ſerve to ſhew, by due notations and diviſions being made thereon, the* tenth parts of this ſmalleſt weight, as the addition of weights placed on the cup, or top of the ſtem, ſhews by the ſum of ſuch weights the whole value, or ſpecific gravity of the ſubject.

When the inſtrument is ſo adjuſted as to ſink to the top of the ſtem in *rain-water*, every other water to which it may be applied will occaſion it to riſe by juſt ſo many diviſions, or tenth parts of the ſtem, as ſuch water may be inferior to rain. And, as every other water *is* inferior to rain-water, hereby the local differences in water are found moſt preciſely. Should it happen that any water ſhould be ſo heavy as to require a farther power to ſink the inſtrument to ſome part of the ſtem, the ſmall weight before mentioned

* By noting the diſtance between any two of the diviſions, where the inſtrument may fix, we are ſhewn the ſpecific gravity of the ſubject to the *twentieth* part of the ſtem; if curioſity or any other motive ſhould at any time induce us to be ſo exact,

then

then ſerves to repreſent ten additional notations, or diviſions.

Having thus found the ſpecific gravity of the water employed in brewing, and deducted the ſum of its weight from the ſpecific gravity of each wort reſpectively, the remainder ſhews, by the ſame ſcale, the denſity or ſpecific gravity obtained in ſuch wort or worts from the malt.

Now, whether this ſcale or ſum is expreſſed by any fixed and definite term, as grains, ounces, or pounds; or whether it is pointed out to us by a ſimple number, without any other meaning than the relative proportion of 100 to 500, or to 1000, muſt be a matter of the moſt perfect inſignificance to us. For, where can be the difference in the concluſion or inference, whether we ſay that the ſpecific gravity of a wort, or the average of two or more, amounts to 25 ounces of fermentable matter, or whether the acquired denſity is indicated by a certain number, or ſum, as 200, 300, 350, with the intermediate

termediate numbers to the greateſt accuracy as 1 from 100 to 700, or more?

As a proof that the hydrometers made by various hands are, or may be rendered, equally ſerviceable, the author has occaſionally uſed no leſs than five; all differing in their ſcales; but each of which he he has, in a ſhort time, with little trouble, and to great or fully ſufficient exactneſs, reduced to one and the ſame ſum of indication. He has, for ſeveral years paſt, uſed Quin's hydrometer; ſtill noting the value or ſpecific gravity of each wort, in the ſame terms, and by the ſum which the ſame wort would cauſe Martin's inſtrument to expreſs. The reaſon for which is nothing more than his having long been in the habit of determining the aggregate value of a given quantity of malt, by the ſcale of Martin's hydrometer. Which ſcale, as it is thereby become familiar, more readily gives him a reference to the comparative value of the ſame quantity of malt, made from barley of the preſent or any preceding year.

The

The accuracy of any hydrometer is to be proved moſt eaſily, and moſt effectually, by mixing equal quantities of two worts; both of which have been previouſly weighed by the ſame inſtrument. For inſtance, if the ſpecific gravity of a firſt wort is exhibited by the power 600, and of a ſecond wort by the force of 300, equal quantities of the two would require juſt 450, to ſink the inſtrument to the ſame point in their mixture, after it has been duly agitated to make ſuch mixture complete.

This, therefore, is the criterion of the goodneſs of the inſtrument. And if the reſpective weights are graduated as they ought to be, and as they generally are, or always might be, the event will anſwer moſt preciſely.

It may, perhaps, be ſomewhat amuſing to the reader to be told, that this was the objection which Mr. Martin himſelf urged to the author againſt his own inſtrument. But the truth of the propoſition appeared to be ſo ſelf-evident, that the

author

author had never troubled himſelf to make any trial of it. Startled, however, at what had been ſaid, he ſtated the matter to the gentleman formerly mentioned, who the next day furniſhed him with the means of determining it, by directing proper quantities of a firſt, a ſecond, and a third wort to be ſet apart, in a due ſtate for the purpoſe; when, after aſſaying each ſeparately, the mixture diſcovered, to a five hundredth part of the whole, the expected medium of the different worts; thereby proving the extreme accuracy of that very hydrometer, which its own maker had endeavoured to depreciate. The ſucceſs of ſuch an experiment as this muſt therefore be concluſive, as it muſt be ſufficiently and fully ſatisfactory to the brewer, whichſoever hydrometer of the various kinds now made he may think proper to employ.

If the weights appertaining to any of theſe inſtruments are formed exactly true, and there ſhould, nevertheleſs, appear a trifling difference between the calculated and

and the actual ſpecific gravity of a mixture of worts; this may be imputed to the force of attraction, or adheſion, occurring in this inſtance moſtly, if not excluſively, in a firſt wort; which in a brewhouſe, where a very large quantity of malt is maſhed, and of hops are boiled in one operation, is uſually exceedingly denſe. And thus, on immerſion of the hydrometer in ſuch an extract, ſome of the particles of this wort, adhering to the ſtem of the inſtrument, from their glutinous property, are apt to deſtroy the accuracy of the obſervation.

To remedy this inconvenience, which, from the nature of it, will be found more frequently in the London than in the country brewery, a mixture of ſuch rich and denſe wort with a ſecond or third extract, previouſly weighed, is effectual.

Whatever inaccuracy may remain after this deciſion, if carefully and ſkilfully performed, may, as has been before hinted, ſerve to amuſe or to employ philoſophers; but is no more worthy the at-

tention of the practical brewer, than the waſte liquor or water which runs from the waſhing of his caſks.

Much of the accuracy of the inſtrument depends on the keeping every part of it, together with the weights, ſcrupulouſly clean.

The variations occaſioned in the ſpecific gravity of the ſame wort, or liquor of any kind, by the different temperatures of heat, are to be noted; and additions or deductions are to be made, according to the tables of heat, uſually delivered with each inſtrument; which tables are generally ſufficiently accurate, as the variations need never be conſiderable. Their truth may, however, be readily proved by the brewer's own experience and obſervation.

SECTION IX.

On BARLEY *and* MALT.

THE frequent and material diſproportion which is by our inſtrument diſcover-

able

able in the produce or real value of the malt made from barley the growth of the ſame neighbourhood, perhaps of the ſame pariſh, ariſes principally from the inattention of the farmer to the ſtate of the barley while in the field. Immenſe is the injury ſuſtained by the conſumer every year, from the miſconduct of mowing this kind of corn a very few days before it is arrived to perfect maturity. The ſingle and trifling circumſtance of having no other immediate employ for a labourer, whoſe weekly pay and ſubſiſtence do not perhaps exceed twelve ſhillings, often outweighs every other conſideration, to the exceſſive damage of the corn, and to the proprietor's own conſiderable loſs, ultimately, by a deficiency in the yield or meaſure.

How ſtrange does it appear, that people, more attentive generally to profit than to every other concern, ſhould eſcape the diſcovering that they ſuſtain more injury by a ſervant's labour in ſuch a caſe, during a part only of one day, than is to

be equalled by the whole amount of his wages for the week.

Some part of the inferiority of barley is likewiſe owing to its being carried from the field before it is perfectly dry or withered. And, even if it ſhould have been ſufficiently ripe before it was cut, and no rain ſhould have fallen on it afterwards, ſuch haſte, by weakening its vegetative properties, leſſens the quantity of ſweet or fermentable matter, otherwiſe obtainable from its malt.

The inſtrument of which we have been treating, although it cannot pretend to direct us clear from ſuch inconveniencies, in the firſt inſtance, will, moſt aſſuredly, in the event, afford ſuch important information as cannot fail to direct in the ſelecting thoſe farmers, who, as ſellers of barley, are, on account of their induſtry and ſkill, moſt deſerving of the brewer's encouragement and attention.

Thus, if he brews to-day with malt made from barley purchaſed of one farmer, and to-morrow with malt the produce of another

another man's corn, ſhould he find any conſiderable difference in the yield of the two brewings (the malting of both being as nearly as can be judged ſimilar) hereby is afforded a direction as to the price to be given for each barley; or if, which is very probable, no difference can be obtained in the price, the brewer will of courſe know which to prefer.

It has ſometimes happened that, at the commencement of the barley harveſt, a few days of very fine weather have been followed by a continuance of rain, for ſome weeks, hence the barley has been exceedingly different in appearance; but, owing to the firſt part of the produce being cut ſome days before it was ripe, we have known an inſtance when the intrinſic difference in value, between the bright and the ſtained barley, was not more than 1s. 6d. or 2s. per quarter, although the difference made between them in price, in the markets throughout the ſeaſon, was 6s. or 7s. per quarter.

This caſe happened within the very firſt

year that the author had provided, and turned his thoughts to the uſe of an hydrometer; which, therefore, was ſerviceable to him to the poſitive amount of four ſhillings per quarter on the remainder of his purchaſes of barley, during that ſeaſon, or after he had, by the uſe of the hydrometer, according to the preceding rules, informed himſelf of the actual and preciſe value of each ſort.

This was in ſome meaſure the caſe, likewiſe, with the barley the produce of the harveſt 1782. The very ſmall portion whereof, which was free from ſtain, ſelling at a greatly increaſed price, compared with what could be obtained for the far greater part of the barley of that year, which indeed was remarkably dark and damp. But that which fetched the higheſt price was very thin, light, and unripe; conſequently the malt was very poor and unproductive.

In the beginning of that ſeaſon we made ſome malt, which, eſtimated with the produce of the year 1781, was only

as

as 29 to 54, which is an inferiority in the quality only (and not to mention the advanced price of the barley) of 46 per cent.

This however was particular; but the average value or produce of our malt in 1782, compared with the malt made from the barley of 1781, was as 39 or 40, to 54, which is an inferiority of 26 per cent.

It may be fairly preſumed that this extreme difference was pretty general throughout the kingdom. Notwithſtanding which, the brewers, for the moſt part, drew longer lengths from the malt of that bad ſeaſon than had been attempted when the quality was ſo much ſuperior as perhaps to have borne ſuch increaſe of quantity. This was done with a view to make themſelves ſome amends for the extreme high price of this malt; what then muſt have been the condition of the beer?

That there was a neceſſity either for an advance in price, or for a reduction in quality, muſt be allowed; but the mea-

ſure of ſuch reduction could be known only by the uſe of an hydroſtatical inſtrument; becauſe the difference in the quality of the malt, compared with the produce of former ſeaſons, was greatly beyond what was generally imagined.

SECTION X.

On the THERMOMETER.

ALTHOUGH it was not a part of our preſent plan to ſay much of the thermometer; yet, frequent mention having been unavoidably made of that inſtrument, the uſe of which is neceſſarily involved in our preſent ſubject, as well as in other material parts of the proceſs of brewing, it may not be ſuperfluous to take a little farther notice of it; more eſpecially ſince, notwithſtanding the extreme uſefulneſs of the thermometer is now generally known and acknowledged in the brewery, it will ſtill be ſaid by ſome, that much better beer is brewed in private families, or, as it is more commonly called,

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in the home-brewed manner, without a thermometer, than is obtained by the public brewer with all his inſtruments and all his art. And that, moreover, a thermometer appears to be wholly uſeleſs, as to the extraction or maſhing, ſince boiling water, without which ſome people perſuade themſelves they ſhall never procure any malt liquor which will be drinkable, or keep ſound even for a few months, is diſcoverable in water by the eye on the firſt inſtant that the fire has brought it to that point.

We ſhall anſwer ſuch remarks by an aſſertion, which we will be confident to make, namely, that the indiſcriminate uſe of boiling water only, applied to the malt, is an abſolute waſte or loſs of one-fourth, and in many caſes of a ſtill greater part of all the malt that is ſo treated; or that, in other words, three portions of malt wetted with water of the *proper* degree of heat, will poſitively produce as great a quantity of wort or beer, of any certain required ſtrength, as can be obtained from four like portions of

of the ſame malt, if wetted with all boiling water; which, inſtead of extracting the valuable properties of the malt, hardens it into balls and clods, and prevents it from yielding any other extract than ſuch as to reſemble whey, and, though turbid, greatly deficient in ſweet, which is the valuable matter. For, heavy to the eye, and thick, as ſuch a wort may be, it will be found to be of much leſs ſpecific gravity, as well as leſs in quantity, than that which is to be obtained by a more mild and gentle infuſion; which, provided the heat is proper, that is, neither too high nor too low, both of which are equally to be avoided, produces a wort clear even to tranſparency, rich and ſweet to the taſte, and duly tinged with the colour of the malt, according to the degree of heat which was obſerved in drying it on the kiln. The product alſo, provided the other parts of the proceſs are conducted as they ought and may be, will in one inſtance be perfectly fine and bright at the end of a very few months, and continue

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in a ſtate of preſervation or ſoundneſs as long as can be needed or required. Whereas, in the other caſe, the beer will have no tendency to clearneſs within leſs time time than twelve, or perhaps eighteen months, and will then probably be harſh and ſtubborn to the taſte, and heating and unwholeſome in its effects.

This laſt conſideration is the only one that may be likely to have any force. With the private brewer, whoſe humour may lead him to wiſh to excel his neighbours in the occaſional production of this liquor at table, the coſt of it is ſeldom much regarded. If ten buſhels of malt are not found ſufficient to obtain an hogſhead of very ſtout beer, twelve, fourteen, or ſixteen buſhels are allowed. So likewiſe, if the beer does not become fine at the end of ten, twelve, or fifteen months, it is ſuffered to ſtand untouched for the ſpace of eighteen or twenty-four months; and the age of the beer, which is in fact nothing more than the conſequence of ignorance,

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is then mentioned as one of its ſtrongeſt recommendations.

The caſe of the public brewer is extremely different; under all the diſadvantages of an high price for barley, or malt, and loaded with an heavy exciſe on his beer, he is required conſtantly to produce a clear and nouriſhing liquor, at ſuch a price as will enable the retailers to ſell as cheaply as was done in moſt parts of the country ſixty or eighty years ago, when the prices of corn and the attendant charges did not amount to one half of the preſent coſt. He cannot therefore afford to be regardleſs either of a waſte of malt in the outſet, or of a loſs of time in the conſumption of his beer. The ſooner this can be rendered ſaleable, the leſs will be the weight on the brewer occaſioned by his ſtock; which, although it is in all caſes in this buſineſs unavoidably great, may be made to vary, ſo as effectually to anſwer every fair and deſirable intention, ſimply by uſing proper heats in the two moſt important

portant parts of the proceſs of brewing, extraction and fermentation.

And theſe heats, which are alſo to be various as the different kinds of malt uſed, as the ſeaſons of the year, and as the intentions or views of the operator, may be obtained at all times, by the thermometer, to the utmoſt preciſion and exactneſs. Yet it is not to be expected that every one who uſes a thermometer can benefit by it, to any conſiderable degree, at the firſt. Put a watch into the hands of a perſon who has never been uſed to a time-piece, and he cannot tell you what is the hour. Here however is the beſt field for obtaining ſuch right information from experience as is not otherwiſe to be expected; for the boaſted experience of practitioners, in common, is founded on no kind of rule or baſis. The eye or the touch can afford no tolerably certain direction as to the heat of water below the boiling point, or as to the heat of worts otherwiſe than according to the accidental warmth of the finger, at the time it is ap-

plied. The natural heat of the human body in health is 96 degrees by Fahrenheit's thermometer. In the ſummer months the touch applied to worts, ſomewhat below that degree, will indicate them to be cool, when, perhaps, their actual heat may be ſuch as to be very unfit for the purpoſes of a profitably vinous fermentation. On the other hand, the external air in ſevere weather being at or below the freezing point, a vapour will be ſeen to aſcend from worts, and the extremities of the body being alſo at ſuch time moſt liable to be affected by the cold, the finger may likewiſe then diſcover a *comparative* warmth in worts, although they may be ſunk conſiderably below that heat which might be requiſite to excite and ſuſtain a due and complete fermentation.

SECTION XI.

Application of the HYDROMETER, *in directing the Extraction and Fermentation of Sweets.*

WE have ſaid that the hydrometer is of great ſervice to all who are intereſted in forming liquid extracts, of whatever denominations. The proceſs of brewing for the malt diſtillery being exactly ſimilar to the brewings for ale and beer, excepting that in the former the hops and, of courſe, the boiling are omitted, what has been obſerved, relative to the forming average or ſtandard gravities in the brewery, will apply alſo to the malt diſtillery, as well as to making vinegar from malt.

In the buſineſs of ſweets the caſe is different. The extract yielded from the uſual ſubject, dried fruits, is obtained not altogether by infuſion, but in ſome meaſure

meaſure by the operation of fermentation. That is, after the water and the fruit have been ſo long together, as that ſome portion of the ſweet is extracted, this extract being fermentable matter, a fermentation ariſes ſpontaneouſly; which fermentation acts with increaſing force on the ſweet remaining in the ſubject, until the whole is extracted, as is proved by taſting the huſks, which will be found to be vapid, and void of all ſweetneſs. At this criſis the liquor ſhould be drawn from the fruit, in order to its becoming completely vinous by ſuch farther fermentation, time, and different rackings, as experience or the particular circumſtances of the wine itſelf may appear to require.

This being, we believe, the proceſs commonly obſerved in the making of wine from ſweets, we will venture to propoſe a method of applying the hydrometer herein, which appears to be practicable to conſiderable advantage.

The weight of the water being firſt aſcertained, and the fruit having been infuſed

infuſed therein a few days, it may be proper to draw a ſample of the liquor or extract, and, taking the ſpecific gravity thereof, to note it in a book kept for the purpoſe. Suppoſe, according to the ſcale which we have all along obſerved, the denſity acquired in this time ſhould prove to be as 100 by our inſtrument—ſuffering the whole to remain two or three days longer, we ſhall perhaps find it to be as 200, on drawing and examining a like ſample. Proceeding in this manner to make obſervations on our ſubject, every two or three days, we ſhall probably find the ſpecific gravity thereof to be, in a due time as 18 or 20 days, as much as 600. The matter now becomes critical; and, therefore, requires examination every twelve hours. Should we, at length, obtain ſuch a denſity as 700, and at our next examination (twelve hours afterwards) find that the ſpecific gravity is ſunk down to 680, or in ſhort to any number leſs than 700, hereby we are taught that the extraction is completed,

and that the only proper office now remaining for the fermentation is to attenuate the extract ſo much as to produce a perfectly clear, and truly vinous liquor; which purpoſe is, from this time, effected to greater advantage with regard to flavour and preſervation, if, as before mentioned, the liquor is drawn from the huſks, which can now communicate no property in the ſmalleſt degree deſirable or advantageous *as to the wine*. Whether they may ſerve for any other purpoſe worth attention, as the making of vinegar, or aſſiſting thereto, is another conſideration.

The application to be made of theſe examinations of the liquor during its continuance on the materials employed, (but more eſpecially of the *laſt* examination) is analogous to the inferences which we have drawn from the ſpecific gravities of worts. As we are *there* taught the preciſe value of different lots or parcels of malt or barley, together with the means of having our beers uniform in ſtrength; *here* we gain

gain a clue to diſcover the preciſe value per hundred weight, of fruits of all denominations, together with the opportunity of making up ſweets, or the wines, from them, to any required or ſtandard ſtrength; which, as in the caſe of beer from worts, will be found to be in an exact proportion to the *higheſt gravity*, ever diſcovered in the different infuſions or extractions.

The liquor or extract, thus impregnated with all the ſweet obtainable from the fruit, and being ſeparated from the huſks or ſkins by racking, is now in a very high ſtate of fermentation; which continues until the fermentable matter is thereby ſo far attenuated, as to change from ſweetneſs to vinoſity. Here again is a field for advantageouſly employing an hydrometer; firſt monthly, and after ſome time weekly. The gradation is however reverſed; for in proportion as the ſweet is leſſened, the liquor now becomes more ſpirituous, and therefore lighter; which effect will be progreſſive, as the inſtru-

ment will demonſtrate, until the liquor *(then wine)* is reduced in gravity to an equality with, or a trifle leſs than water.

When the fermentation, however, has proceeded ſo far as to reduce the ſpecific gravity from its higheſt point down to 150, or 100; it is prudent that the wine ſhould be a ſecond time racked from its lees, as well to give it an opportunity of fining more effectually, as to reſtrain, in ſome degree the fermentation. Which might otherwiſe proceed from the vinous to the acetous, and thus produce vinegar inſtead of wine. Yet the moderate check which it receives from this ſecond racking, is not ſufficient to deſtroy the deſirable attenuation of the remaining ſweet. So long as any portion of that exiſts, the fermentation will continue. But, in the inſtance we are now putting, the operation will be ſo gentle as to contribute to the ſoundneſs and preſervation of the wine, no leſs than to its clearneſs and ſpirituoſity.

This method of regulating the fermentation

tion of ſweets by the application of an hydroſtatical inſtrument, will be found to take away the neceſſity of adding ſpirits, in order to preſerve or improve them. Which practice, although it is very common, is not only uſeleſsly expenſive, but alſo highly injurious to the flavour of the wine, and perhaps to the health of the conſumer. It has accordingly, more than any other cauſe, tended to bring theſe wines into the diſrepute they generally lie under. The ſpirit, uſually introduced herein, is Britiſh, and probably not always the beſt even of this ſort; but is new, coarſe, and fiery; communicating to the wine a diſagreeable flavour, and a miſchievous quality.

Would thoſe houſekeepers, who undertake to form this liquor for their own table, give themſelves the very ſmall trouble to make an arithmetical calculation, as to the difference in expence attending the addition or omittance of ſpirits, they would diſcover that the coſt of the portion (required to have an effect

of any kind) of the cheapeſt brandy, would ſerve to preſent to the wine an increaſe of fruit, amounting to nearly two pounds per gallon; and the product of ſuch an extra allowance of the fruit, extracted and fermented with ſkill and aſſiduity under the guidance of an hydrometer, would not fail to remove the prevailing notion, that this wine is not to be made without the addition of brandy, as well as the common prejudice againſt it as an unwholeſome liquor.

APPENDIX.

APPENDIX.

IT was very much the author's wiſh to avoid all occaſion of noticing a late publication, on the preceding ſubject. But, as that work may, by ſome, be thought to have precluded the uſefulneſs of the preſent treatiſe, it becomes incumbent on us to make ſome remarks on the differences which will appear in our mode of forming average ſtandard gravities (which is the foundation of the principal advantages to be derived from the inſtrument), and in that method, which is recommended in the Statical Eſtimates.

It may be obſerved, from all that we have hitherto ſaid, that in *principle* we agree with that author moſt entirely; in *practice* we differ from him very materially.

It is no more than juſtice to Mr. R. to ſay, that his laſt and former publications ſhew him to be poſſeſſed of more knowledge in the brewery, than any other perſon who hitherto appears to have written on the ſubject. His inſtrument likewiſe may, with ſome alteration, be rendered as proper for the brewer to adopt, as any other of the kind.

But, with regard to that part of the ſaccharometer which is the only novelty of it, as an hydroſtatical contrivance, the regulator, impartiality demands of us to ſay that this may be diſpenſed with, even to the improvement of the inſtrument; as well with regard to accuracy, as to the convenience and diſpatch of its application.

Having gone ſo far as to aſſert this, it will be required of us to explain our reaſons for entertaining this opinion; and, alſo, to propoſe ſome other means for diſcovering the differences in water; which is a circumſtance allowedly eſſential. This then may, in our judgment,

ment, be done effectually, by making the lower ſtem of the ſaccharometer fixed as the upper, and by having the whole inſtrument ſo adjuſted as to ſink to $^{b}\ominus$ (fig. 1. in the plate engraved for the Statical Eſtimates) in rain-water.

Every other water will then occaſion the inſtrument to riſe, in proportion as ſuch water is heavier than rain *; whereby the differences in water might be found moſt preciſely. And thus the regulator, which is a great incumbrance, would be rendered unneceſſary.

To this it may be added, that, notwithſtanding all the care and ſkill of the maker (which are not to be diſputed), it appears to be ſcarcely poſſible, where the inſtrument is daily or much uſed, to prevent the regulator from being moved from its ſtation, by very ſlight and unavoidable incidents.

For, the friction of frequent uſe will be found to wear the piſton and the tube,

* Vide page 60.

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ſo much as to occaſion the movement we have juſt mentioned. And, when this is the caſe, it can no longer be expected that they ſhould be perfectly air-tight; as they are intended, and, to be uſeful, moſt aſſuredly ought to be. If it ſhould be aſked how we can judge of the practicability, or otherwiſe, of conſtructing any part of the inſtrument, we muſt anſwer, that our obſervation, in this caſe, is drawn from what we have experienced in a ſaccharometer; which, we doubt not, becauſe we were ſo aſſured by the maker, was one of the beſt that had been conſtructed.

But a ſtill more exceptionable part of Mr. R's. ſyſtem is his method of forming average and ſtandard gravities. All the philoſophical nicety and attention which he has beſtowed on the regulator, even if they were of any uſe, are much more than counterbalanced by his manner of determining this, which is the grand eſſential point. It is beyond meaſure ſurpriſing, that a perſon of Mr. R's. knowledge

ſhould have been ſo much miſtaken, as to neglect a plain and eaſy road, and to be found wandering in the paths of doubt and uncertainty. What occaſion can there be for the brewer, in order to learn the average gravity of the day, or to form the ſtandard denſity of his guyle, to perplex himſelf with the gravity of his worts, in the under-back, or copper? Or why truſt to what is ſuppoſititious, when he may, with leſs than a tenth part of the ſame time and trouble, obtain a certainty? Why, inſtead of making a great variety of trials on the worts in the copper, and depending on calculations as to the quantity to be evaporated, and as to the expected final denſity of his worts; why not wait for their *actual* denſity when in the coolers? At which time, alſo, *and not till then*, the quantities of each wort may be preciſely aſcertained; without which, all deciſions as to the average gravity muſt be vague, and in no caſe to be relied on.

It may be ſaid that the whole buſineſs

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is rendered certain, by means of tables and calculations, formed on purpoſe to aſcertain the final quantity and quality. We forbear to ſay much on this head; becauſe Mr. R. acknowledges that theſe calculations do not always correſpond with the event. Nor is it probable that they would ſerve as directions in all other offices or ſituations, even if they were leſs fallible in that brewhouſe, where they were firſt formed.

In forming average ſtandard gravities, either with two or with three worts, the foundation of Mr. R's. ſyſtem is to reduce the quantity of the laſt wort, by evaporation, ſo much as to leave the quantity as well as quality, juſt ſuch as will ſerve the intention.

Thus in the caſe of a guyle compounded of two worts for ſtrong, fixing the average at 29,8 pounds per barrel, and finding the ſpecific gravity of the firſt wort to be 34,25 when cool; the ſecond wort, on a ſuppoſition that their quantities were to be finally equal, muſt be

be of the denſity 25,35, to produce ſuch average.

Now, this ſecond wort, when raw, proving to be no more denſe than as 17,6 pounds per barrel (but being improved by the hops and the firſt wort retained in them to 20 pounds per barrel) muſt be evaporated, by boiling in the copper ſuch a length of time as ſerves to bring it to the denſity required, or 25,35. This is to be effected by evaporating 7,4 barrels out of 29,4 barrels.

Of theſe 7,4 barrels, 5,4 barrels are to waſte in the copper; the remaining 2 barrels are ſuppoſed to evaporate in the paſſage of this wort from the copper to the cooler, including its continuance therein.

Again, in the caſe of three worts intended to form one guyle, fixing the average at 25,55, and finding the amount of two parts (the two firſt worts) to be as above, 59,6; the third wort, on a like ſuppoſition that the final quantities are to be equal, muſt be of the denſity 17,05, or ſay, 17, to produce ſuch average.

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This laſt wort therefore, which, while raw, goes into the copper at a gravity of 9,25 pounds, and by the addition of hops and of ſecond wort left in them is increaſed to 11,5 pounds previous to boiling, muſt be evaporated by ſuch a continuance of boiling, as ſuffices to bring it to its required denſity 17.

In all theſe caſes, alſo, the quantity to be turned out of the copper is to be judged, not by gauging, for that Mr. R. ſays is here impracticable, but the whole amount of fermentable matter contained in the wort in the copper, being reduced to one ſum, or aggregate, is ſuppoſed to be fixed; or, in other words, as the quantity leſſens by evaporation the quality of the remainder is improved.

Thus, the preſent wort conſiſts of (including what is added to it by the hops,) 30,26 barrels at 11,5 pounds; the aggregate or whole fermentable matter whereof is, therefore, 358,99. If, after it has boiled two or three hours, we take an obſervation, and ſhould find the

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ſpecific gravity to be 14,5 pounds, dividing this in 358,99, the quotient ſays that 24,75 barrels only are now remaining out of the 30,26 barrels which went into the copper. And the brewer is to form his final quantity as well as quality, by means of a frequency of ſuch examinations of his laſt wort, while in the copper.

The quantity of raw wort, which went into the copper, was 30,26, or ſay 30 barrels and a quarter. To occaſion a ſufficient increaſe in the denſity of this wort, ſo as to form the average required, no leſs than one third part of that whole quantity is to be evaporated.

Let the practical brewer conſider well this circumſtance, and, paſſing over the doubt and uncertainty of ever hereby obtaining the preciſe ſpecific gravity required, let him obſerve ſomewhat on the great waſte of time, fuel, and of ſo much of the pleaſing qualities of the hops, as may yet remain in them, cauſed by this method.

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Whenever it happens that the worts, all or any one of them, are inferior in gravity to the example, (which we have taken from the Statical Eſtimates) the evaporation of the laſt wort becomes, neceſſarily, ſtill greater. And what the produce of the malt may be, no one can foreſee or venture to judge. For our own part, we ſhould be unwilling to ſpeak within 5 per cent. of the expected value of the malt uſed in the operation of any one day, previouſly to having aſcertained the yield, when in the coolers, by our inſtrument.

Putting the caſe therefore, that three worts are intended to form one equal liquor, by being fermented together, and that on examining the two firſt worts, already boiled off, and laying in the coolers, and taking alſo the third wort, in its raw ſtate, in order to attain the means of producing the average gravity required, the quantities and qualities ſhould reſpectively be found to be as follows: viz.

Firſt

	Barrels.		Pounds.
First wort	21,5	at	33,25
Second	22,	at	24,5
Third (raw)	30,26	at	8,25

Purſuing the method of calculation laid down in the Statical Eſtimates, we find that the third wort, which in its raw ſtate was no more than 8,25 pounds, muſt (in order to render the final quality of the aggregate 25,55) be improved by evaporation to 16,9 pounds of fermentable matter per barrel; which will require a decreaſe in the quantity of 13,86 barrels out of 30,26, or 499 gallons out of 1089 gallons. Of which 499 gallons, 434 gallons are to evaporate while the wort is boiling in the copper; and the remaining 65 gallons are expected to fly off in the paſſage of the wort from the copper to the cooler, including its continuance therein.

We truſt it cannot be ſaid, that we have here made an unfair ſtatement, by putting a caſe, as to the yield or value

of the malt, not likely to happen. Neither will the brewer have it in his power to prevent the neceſſity of ſuch exceſſive evaporation, by judging previouſly of the quality of his malt, or by forbearing to apply the uſual quantity of water in the third extract, on finding the ſpecific gravities of the firſt and ſecond worts to be inferior to his expectations. For, the third wort, according to the neceſſary procedure, is wholly run off from the malt, and lodged in the copper for boiling, previous to the examination of the two firſt worts in the coolers. So that no opportunity is afforded of leſſening the quantity, with a view to improve the quality of the extract, otherwiſe than *by* evaporation, ſo far as that goes.

The inferiority of the malt in the preſent example, compared with the actual brewing in the Statical Eſtimates, is not 7 per cent. And as to the probability of the brewer being miſtaken in the previous judgment which he may form of his malt, to ſuch an amount as 6 or 7 per cent.

cent. we ſhall not refer to what we have ourſelves already ſaid on that ſubject; but ſhall quote the remark of Mr. R. Statical Eſtimates, p. 73, where, ſpeaking of two ſpecimens of the produce of *the ſame kind of barley*, under the management of two different maltſters, he ſays, "In "the former there is a ſuperiority over "the latter of 9 per cent. a conſiderable "difference; to an amount which, in moſt "commercial concerns, is deemed a fair "profit; and yet theſe two parcels of "malt would have paſſed, among com-"mon conſumers, with this ſimple ob-"ſervation, that this *ſample is freer* "*than that*; the difference in ſale would "not, perhaps, have exceeded a ſhilling "per quarter, and the brewer would "have thrown them indiſcriminately in-"to his maſh ton, drawing his uſual "length from each, to the poſitive loſs "of 9 per cent. either in the quality of "his liquor from the latter parcel, or in "the obtainable profits of his trade from "the former; which ever might happen

" to tally with the general quality of the " malt he uſed."

We agree moſt cordially with Mr. R. in every ſyllable of the above remark; as we do with him, we can with ſtrict ſincerity ſay, in every part of his book, excepting all that relates to the means of obtaining average and ſtandard gravities; which, we are ſorry therefore to obſerve, is the corner-ſtone of the whole.

We forbear to comment at large on the method of forming the length, by frequently taking the ſpecific gravity of the laſt wort, in the copper. We believe that very few brewers will truſt entirely to ſuch obſervations, in this point, however much they may be aſſiſted by the tables and calculations, formed purpoſely for their direction herein.

We imagine the operator will take a ſingle guage of his worts in the coolers, which cannot engage him more than a minute; juſt to note how nearly *this actual* quantity *(which is really final and certain,)* correſponds with thoſe calculations;

tions; the obſervance of which has neceſſarily required his previous attendance at the copper-ſide during ſeveral hours.

And what if he ſhould then find (which is a caſe not at all unlikely to happen) that the actual event, both as to quantity and to quality, ſhould be widely different from his expectations, as grounded on the tables and calculations?

Would he in ſuch a caſe, we ſay, govern himſelf with regard to his length, and the ſtandard average gravity of his guyle, by this actually final event; or would he finiſh the operation of the day, not regarding what his quality really and truly may be, but what it *ought* to have been according to the calculations?

To conclude. In all that has been ſaid on the ſubject of Mr. R's. ſaccharometer, and on the method of applying it, we truſt that we cannot be ſuſpected of having any other motives, than what ariſe from an earneſt deſire to render the uſe of an hydroſtatical apparatus leſs difficult, in order

der to its becoming general in the brewery.

With regard to the inſtrument, we have no maker whom we wiſh to recommend, or to prefer on any other conſideration, than as the inſtruments themſelves may be well finiſhed, and perfect of their kind. In this view Mr. Troughton ſtands as forward as any one we know, or have heard of. And, if the regulator *muſt not be given up*, let the practical brewer inform himſelf, by a few obſervations, what are the differences occaſioned in his worts, by the piſton of the regulator being ſhut wholly into the tube. Suppoſe the difference between the fixing the regulator at the point required to ſink the inſtrument to $^{b}\ominus$ and between the ſhutting it wholly in, ſhould be 0,6, or ſix tenths of a pound. If a wort ſhould contain 24,8 pounds of fermentable matter, as exhibited by the ſaccharometer when the piſton of the regulator is quite cloſed into the tube—the brewer has only to call the ſpecific gravity of ſuch a wort

25,4 pounds, in order to be fully as accurate as he would be by ſetting the regulator.

As to the method of forming average or ſtandard gravities, it muſt evidently be a matter of indifference what are the means made uſe of, provided the end is obtained. Our own general obſervations during the proceſs of brewing, and indeed an experiment which we made, purpoſely with a view to judge of the propriety and practicability of exceſſive evaporations, are not at all in favour of that method. We chuſe, however, to leave the deciſion of this matter, to the practice and examinations of other brewers; who may, perhaps, perform the operation with more ſucceſs. Obſerving only, that although it ſhould be found to be practicable, it muſt unavoidably be tedious and inconvenient. And even if the brewer ſhould have ſo much perſeverance as to diſregard all other conſiderations, one ſtill remains which is of the utmoſt importance in the preſent concern; namely,

namely, the doubt and hazard of ever, hereby, obtaining the exact average, or ſtandard gravity required.

Thoſe brewers, therefore, who may be induced to uſe an hydroſtatical inſtrument conſtantly, will, of courſe, adopt that method which they may ſeverally find to be to themſelves moſt eaſy, moſt convenient, and, in the final event, as to quantity as well as quality, moſt certain.

FINIS.